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ABSTRACT

This study investigated the effect of hypermedia on enhancing vocabulary learning among non-native English speakers. Participants were 63 volunteer, international graduate students, enrolled in an Intensive English Program, English as a Foreign Language, or graduate program at a mid-Atlantic university. Variables measured included vocabulary learning, computer anxiety and attitude, and learning patterns. Treatment consisted of five sessions using hypermedia courseware, followed by a posttest and retention test 2 weeks later. A statistical analysis of the data showed that the participants' performance in achievement increased significantly; computer anxiety decreased; performance in achievement was found to be related to the levels of computer anxiety; and findings on the effects of field dependence/independence were conflicting. The paper provides the theoretical assumptions for a semantic network-based hypermedia learning environment. Tables and figures illustrate the statistical findings. (Contains 30 references.) (ALF)

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THE EFFECT OF HYPERMEDIA ASSISTED INSTRUCTION ON SECOND LANGUAGE LEARNING THROUGH A SEMANTIC-NETWORK-BASED APPROACH

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Because of its advantages of nonlinearness, associativity, flexibility and efficiency (Conklin, 1987; Jonassen, 1989; Hammond, 1989; Heller, 1990) as well as the breakthroughs in storage, graphics and video technologies, the technology of Hypermedia has attracted much interest from the educators. For the past three or four years, literature on Hypermedia has been growing. Its potentials and educational implications are being explored. Since Hypermedia is still a relatively new field of study, little empirical research has been done so far to substantiate its rich theoretical assumptions and verify its promises.

The purpose of this study was to provide some results on the practical application of the Hypermedia technology. It intended to investigate the effect of Hypermedia on enhancing vocabulary learning among the non-native English speakers.

THEORETICAL ASSUMPTIONS

Rationale for A Semantic-Network-Based Hypermedia Learning Environment

Craik and Lockhart' levels of processing theory. Psychologists have classified memory into three levels of storage: sensory store, short-term memory, and long-term memory. While information stored in the short-term memory is only on a temporary basis, the capability of the long-term memory is unlimited and is capable of storing information in a permanent sense. Craik and Lockhart's levels of processing theory (1972) stated that information is processed in a hierarchy of stages with preliminary stages concerned with sensory features such as brightness, pitch, and loudness and later stages concerned with pattern recognition, stimulus elaboration, and meaning extraction. That is, the greater depth of information processing implies a greater degree of semantic analysis (Craik & Lockhart). The more familiar and meaningful the stimuli, the deeper the level of process and the better and longer the information will be retained.

Rumelhart and Norman's modes of learning theory. According to the modes of learning theory (Rumelhart & Norman, 1978), learning goes through three basic modes: accretion, restructuring, and tuning. Accretion is a straightforward addition of knowledge to the existing knowledge structure. Information is simply accumulated, and no modification of the existing structure occurs. Restructuring occurs when the newly acquired information does not fit the current

available memory structure, at which time the existing knowledge structure is reorganized, and a new knowledge structure is sometimes created for interpreting the new information. Tuning involves the continual modification of the existing knowledge so as to improve the accuracy, generalizability, and specificity of the existing knowledge. At the stage of tuning, the performance of a task becomes smoother, more efficient, less hesitant, and more automatic.

Both theories have stated that learning goes through different stages. In order to learn more effectively, new information must be integrated into the existing knowledge structure and the existing information should be reorganized to accommodate new information.

Semantic-network and Hypermedia. As a popular representational format, semantic-network is a conceptual representation of knowledge in human memory (Jonassen, 1990; Norman, 1976). It has been used to facilitate depicting and displaying the operations of human memory through its nodes and linking structure. A major characteristic of Hypermedia technology has been perceived to be its resemblance to the human memory system (Collier, 1987; Conklin, 1987; Jonassen, 1989, 1990). Like semantic network, Hypermedia used the same terminology of nodes and links and is a computerized way of representing the semantic network in human memory. In a Hypermedia environment, logically and semantically related information can be linked together to form a network. It is not only a tool suitable and capable of presenting and representing the knowledge base of an expert on a subject but also a tool that can enable learners to construct their own knowledge bases by making meaningful connections among the ideas they perceive.

According to the levels of process theory and modes of learning theory, to process information at a deeper level often requires building connections between the new piece of information and the existing network of information. In learning a concept, establishing semantic ties between this new concept with existing ones can promote understanding and retention of a concept. The more semantic ties this new concept has with the existing concepts, the more stable it will become. The more stable the concept, the firmer the relationship this concept has with the existing network of information, and the more meaningful and better integrated this concept becomes (Liu, 1992a). Semantic-network-based Hypermedia provides a computerized technology

to facilitate this integration of new information to the existing knowledge structure in human memory and promote knowledge presentation, representation and construction (Nelson & Palumbo, 1992).

Semantic-Network-Based Hypermedia and Second Language Learning

One of the important teaching strategies in second language learning is the communicative approach. The focus of the communicative approach of language learning is not on the mere acquisition of language knowledge but, more importantly, on the appropriate use of the language in different situations (Hymes, 1971; Widdowson, 1981). In order to be able to communicate appropriately with others, one needs the skills of listening, speaking, reading, and writing. The combination of different media such as sound, graphics, text and animation in a Hypermedia environment provides a realistic situation for language learning and makes the process of learning natural and intuitive. The linking capability of Hypermedia can effectively connect phonology, syntax, semantics, and pragmatics of a language and make language learning more meaningful.

Take learning vocabulary, for example. In a semantic-network-based Hypermedia learning environment, a learner can be flooded in an enriched multidimensional cultural context, connecting history, geography, art, cultural customs, and social factors of a target country with the linguistic aspects of the target language. While the vocabulary words to be learned are meaningfully linked to a much larger cultural context, different linguistic features of a word can be more easily focused through a semantic-network-based approach (Liu, 1992a). The flooding can be accomplished by the multimedia aspects of the Hypermedia technology and focusing can be achieved through the presentation and representation capabilities of Hypermedia. Therefore, a semantic-network-based Hypermedia language learning environment could facilitate deeper level of information processing, knowledge accumulation, and knowledge restructuring (Liu, 1992a).

RESEARCH QUESTIONS AND THE PURPOSE OF THE STUDY

This study investigates specifically whether Hypermedia-assisted language instruction improves vocabulary learning among English-as-second-language (ESL) students. It attempted to answer the following seven research questions:

(1) What is the effect of the semantic-network-based Hypermedia assisted language instruction on vocabulary learning?

(2) Does the level of mastery of the subject matter have an effect on learning in a Hypermedia environment?

(3) Which type of learning styles benefit more from a Hypermedia-assisted learning environment?

(4) What is the relationship between learning styles, computer anxiety, attitudes toward computers, and Hypermedia-assisted language learning?

(5) What is the effect of Hypermedia-assisted instruction on improving attitudes toward computers and lowering computer anxiety?

(6) What are the learning patterns of the different achievement groups and anxiety groups in a Hypermedia-assisted learning environment?

(7) Which type of learning aids will best meet learners' different needs?

DESIGN OF THE STUDY

Sample

Sixty-three volunteer, international students participated in the study. These participants were from different countries currently studying in the Intensive English Program (IEP) (n=44), English as a Foreign Language Program (EFL) (n=12), and graduate programs (n=7) at a mid-Atlantic University. The age of the participants ranged from 18 to 41 with a mean of 24.21.

Dependent Measures

Achievement test. Since the study was on vocabulary learning, an achievement test on the included vocabulary was developed. The test consisted of three parts: 80 multiple-choice items, 20 fill-in-the-blank items, and 20 sentence-making items. The achievement test was administrated before the treatment as the pretest, after the treatment as the posttest, and two weeks following the completion of the treatment to evaluate retention. In the retention test, only multiple choice questions and fill-in-the-blank questions were used. The comparison from pre to post to retention was based upon the percentages of the three data collection times. The minimum score for this

achievement test was 0 and the maximum score was 260 for the pre and the post (80 points from the multiple choice questions, 20 points from the fill-in-the-blank questions, and 160 points from sentence making questions), and 100 for the retention (80 points from the multiple choice questions and 20 points from the fill-in-the-blank questions). The content of the achievement test was determined to be valid by a panel of experts. The achievement test comprised of multiple choice and fill-in-the-blank items was reliable: KR(20) = .90. The interrater reliability for sentence making items was .88. for the pretest and .92 for the posttest.

Computer anxiety and attitude. To measure the participants' computer anxiety, a 20-item, 4-point Likert scale modified version of Spielberger's Self-Evaluation Questionnaire was used (Reed & Palumbo, 1987, 1987/1988). This instrument has a reported reliability of .91 and .93. A Computer Attitude scale developed by Richards, Johnson, and Johnson (1986) was used. This 22-item, 5-point Likert scale consisted of three parts: Liking for Computers, Male Domain, and Necessity of Computers. Richards, Johnson, and Johnson reported the reliability of .88/.87, .84/.79, and .72/.75 for the three parts, respectively.

Learning patterns. Learning patterns were measured by (a) the total amount of time spent using the courseware, (b) the total number of times using the courseware, (c) the total number of times accessing different media provided in the courseware (such as text, video, and graphics), and (d) the total number of times accessing the tools provided in the courseware (such as the index tool, the on-line help, the map tool, the notetaking tool, and the exercise tool). Learning patterns were also measured by looking at which type of media, which type of tools and which type of learning aids was selected more frequently for the different achievement and anxiety groups. Five learning aids were provided for each of the 80 vocabulary words taught in the courseware. They included the definition, the part of speech, the sentence examples, the video context and the relationship of the word to other words.

Independent Measures

Treatment. The treatment was a semantic-network-based Hypermedia-assisted-language-learning environment using the *Hypermedia-Assisted-Vocabulary-Learning Courseware* for non-

native English speakers to learn vocabulary. Voyager's *Citizen Kane*, a level I videodisc, was used as the context of language learning and was repurposed to become a level III interactive program using the authoring language *HyperCard*.

The *Hypermedia-Assisted-Vocabulary-Learning Courseware* (HAVLC) developed for this study was based upon the theoretical framework discussed above. It not only flooded learners with a wealth of information through multimedia contextual materials but also provided focus on the linguistic features of vocabulary words through a semantic-network-based approach. The emphasis on the proper use of vocabulary was presented through such learning aids as the definition, part of speech, sentence examples, video context and relationship for each of the 80 target words. Different learning tools (the index, the on-line help, the map, the notetaking and the exercise) were provided to assist learning. Though learner control with advisement was used as the principle for the courseware design, learners had the ultimate control of the choice of the media, the tools, the different learning aids, and how to proceed (Liu, 1992b).

Computer anxiety levels. The posttest computer anxiety scores were grouped into three categories: low, intermediate, and high, based upon the mean (*MEAN* = 36.33) and standard deviation (*SD* = 9.14). Those whose anxiety scores were one standard deviation below the mean were classified as the low anxiety group (n = 13) and those whose anxiety score were one standard deviation above the mean were classified as the high anxiety group (n = 13). Thirty-seven participants belonged to the intermediate group.

Achievement levels. The same method was used to classify the participants into three achievement levels based upon the mean (*MEAN* = 221.27) and the standard deviation (*SD* = 21.18) of the achievement scores, resulting 11 participants in the low achievement group, 11 participants in the advanced achievement group and 41 participants in the intermediate group.

Learning styles. Oltman, Raskin and Witkin's Group Embedded Figures Test (GEFT; 1971) was given before the treatment to classify the participants into field-dependent (FD) and field-independent (FI) learning style groups. The test had a score ranging from 1 to 18 with 18 indicating high field-independence and 0 meaning high field-dependence. Based upon the mean

(*MEAN* = 10.97) and the standard deviation (*SD* = 5.59) of the GEFT scores, there were 14 FD participants, 18 FI participants and 31 participants belonging to the Mixed group, a mixture of FI and FD learning styles.

Pre-proficiency levels. The three pre-proficiency levels (low, intermediate, high) were determined by the TOEFL and the Michigan Test scores of the 63 participants. Based upon the standard the Intensive English Program used to classify the proficiency level of its students, a Michigan score of 120 or below and a TOEFL score of 400 or below were defined as low (n = 21); a Michigan score between 121 and 150 and a TOEFL score between 401 and 500 were defined as intermediate (n = 21); and a Michigan score between 151 and higher and a TOEFL score between 500 and higher were defined as high (n = 21).

Procedure and Analysis

The treatment consisted of an orientation session followed by four instructional sessions. During the orientation session, the participants were given a demonstration of the HAVLC and a hands-on experience. They were also asked to complete the pretest. For each of the 4 instructional sessions, the participants worked on one part of the HAVLC with one person per workstation, learning 20 vocabulary words. Although two hours were allocated for each session, the actual amount of time the participants spent using the courseware ranged from a total of 4.40 hours to a total of 8.37 hours with an average total of 5.75 hours. The choice of the different media, the different tools, the different learning aids, and the time spent by the participants were recorded by the courseware. At the end of each session, they were given the post-achievement test and at the end of the treatment, the participants were given the post computer anxiety and attitude tests. A retention test was also given two weeks after the treatment.

To answer the seven research questions outlined above, ANOVA and multiple regression analyses were conducted.

RESULTS

Achievement

Research question one was "What is the effect of the semantic-network-based Hypermedia assisted language instruction on vocabulary learning?" To answer this question, a *one-way ANOVA with repeated measure* of the pre/post/retention data collection points was conducted. The result showed that there was a significant effect of data collection on achievement from pre-treatment to post-treatment to retention: $F(2,124) = 555.53$, $p < .01$ ($MEAN_{pre} = 31.86$; $MEAN_{post} = 85.14$; $MEAN_{retention} = 78.38$). The post hoc Scheffe F-test indicated that the posttest was significantly different from the pretest (*Scheffe* $F = 468.56$, $p < .05$) and the retention test (*Scheffe* $F = 7.55$, $p < .05$), and the retention test was significantly different from the pretest (*Scheffe* $F = 357.19$, $p < .05$). That is, the performance of the participants increased significantly from pre-treatment to post-treatment. The significant difference between the pre and the retention data collection points indicated that the participants retained much of what they learned.

Research question two was "Does the level of mastery of the subject matter have an effect on learning in a Hypermedia environment?" To answer this question, a *two-factor mixed ANOVA* was used with the pre-proficiency level as determined by TOEFL and the Michigan test scores (low, intermediate, high) as a between-subjects independent variable and the data collection points (pre, post, retention) as the repeated measure independent variable. The dependent variable was the achievement scores. There was a significant main effect of the pre-proficiency level on achievement: $F(2,120) = 17.11$, $p < .01$. The high pre-proficiency level group scored higher. There was also a significant two-way interaction between the proficiency levels and the three data collection points: $F(4, 120) = 3.65$, $p < .01$ (see Table 1 for means). This interaction was due to extreme scores of the three groups at the pre-treatment, but then at the post-treatment and retention points, the scores of the low and intermediate proficiency groups were virtually the same, although, the high proficiency group's scores were still considerably higher.

Research question three was "Which type of learning styles benefit more from a Hypermedia-assisted learning environment?" To answer this question, a *two-factor mixed ANOVA*

was used with the learning styles (FD, Mixed, FI) as a between-subjects independent variable and the data collection points (pre, post, retention) as the repeated measure independent variable. The dependent variable was the achievement scores. There was not a significant main effect of learning styles on achievement: $F(2, 120) = .75$, $p = .47$. That is, there was not much difference among the three learning style groups in terms of how they performed in the achievement test. One group did not perform better than the other(s). Also there was not a significant two-way interaction between the learning style and the data collection (see Table 1).

Insert Table 1 Here

Computer Anxiety and Computer Attitude

Research question four was "What is the effect of Hypermedia-assisted instruction on lowering computer anxiety and improving attitudes toward computers?" To answer this question, *two one-way repeated measure ANOVAs* were run with the data collection points (pre, post) as the independent variable and attitudes toward computers and computer anxiety as the dependent variables respectively. The results showed that there was a significant effect of data collection points on computer attitudes: $F(1,62) = 4.56$, $p < .05$. That is, the study-participants' computer attitudes improved significantly from pre-treatment to post-treatment ($MEAN_{pre} = 91.30$; $MEAN_{post} = 94.03$). There was also a significant effect of data collection points on computer anxiety: $F(1,62) = 22.56$, $p < .01$. That is, the study-participants' computer anxiety was reduced significantly from pre-treatment to post-treatment ($MEAN_{pre} = 41.62$; $MEAN_{post} = 36.22$). These results indicated that the Hypermedia-assisted instruction improved attitudes toward computers and lowered computer anxiety for the students who participated in the study.

Research question five was "What is the relationship between learning styles, computer anxiety, attitudes toward computers and Hypermedia-assisted language learning?" To answer this question, *a multiple regression* was run with learning styles (the continuous scores, not groupings), posttest computer anxiety, and posttest attitudes toward computers as the

predictors and posttest achievement scores as the criterion. The results showed that there was a low but significant relationship among learning styles, computer anxiety, attitudes toward computers, and the achievement scores: $r = .38, p < .05$. This low relationship was mainly attributed to computer attitudes, which had a significant positive relationship with the achievement scores: $t(62) = 2.61$, $p < .01$, *beta* = .82, *beta weight* = .45. That is, those with relatively better attitudes toward computers (at the end of the treatment) generally performed better on the achievement test. Although there did not seem to be any relationship between computer anxiety and achievement scores ($t(62) = .64, p = .53$) nor any relationship between learning styles and achievement scores ($t(62) = .08, p = .94$), the result of a simple regression with anxiety as the predicator and the achievement scores as the criterion showed that there was a trend to predict achievement performance from the anxiety level: $r = .22, R^2 = .05, F = 2.97, p < .09$; $t(62) = 1.72, p < .09$; *beta* = -.5, *beta weight* = -.22, *intercept* = 239.34. That is, low anxiety participants tended to perform better on the achievement than the high anxiety participants. The result of a one-way ANOVA with posttest computer anxiety levels as the independent variable and the post-achievement scores as the dependent variable showed that the mean score of achievement for the low anxiety group was significantly different from the mean score for the high anxiety group, Fisher-test = 16.24, $p < .05$ ($MEAN_{low} = 227.77$; $MEAN_{inter} = 222.73$; $MEAN_{high} = 210.62$).

Learning Patterns

Research question six was "What are the learning patterns of the different achievement groups and anxiety groups in a Hypermedia assisted learning environment?" To answer this question, *four multiple regressions* were run with posttest computer anxiety scores and the posttest achievement scores as the predictors and (a) the total amount of time spent using the courseware, (b) the number of times using the courseware, (c) the total number of times accessing different media, and (d) the total number of times accessing the tools as the criterion respectively for each regression procedure.

Amount of time spent using the courseware. Time spent using the courseware referred to the total amount of time during which a participant used the courseware. The multiple

regression results indicated that there was not a significant relationship among the total amount of time spent using the courseware, the post-achievement scores, and the post-anxiety scores: r = .22, p = .22. Post-achievement scores were, however, found to have a moderately significant negative relationship with the amount of time spent using the courseware: $t(62) = 1.7$, $p = .09$, *beta* = -.71, *beta weight* = -.22. Those with lower achievement scores spent more time using the courseware.

Number of times accessing the courseware. The number of times accessing the courseware referred to the number of times a participant went back to the beginning of the HAVLC to use the courseware for the second or third time after the initial use of the courseware. There was no relationship between the number of times using the courseware and post-achievement scores when factoring in the post-anxiety scores: $r = .21, p = .27$.

Number of times accessing the media. The number of times accessing the media referred to the total number of times a participant used *the text option* which included the definition option, the parts of speech option, the sentence examples, and the relationship option of a word; *the video option* which included the video context for a word and video sentence examples of a word; and *the graphics option* which included the graphic representation of a word.

The multiple regression results indicated that the correlation between post-achievement scores, post-anxiety scores, and the number of times using the media was not significant. However, a look at the mean scores, using ANOVAs, of what type of media that the three achievement levels, and the three computer anxiety levels used indicated some differences.

When grouped by achievement levels. Four one-way ANOVAs were conducted with the posttest achievement levels as the independent variable and (a) the number of times accessing the text media, (b) the number of times accessing the video media, (c) the number of times accessing the graphics media, and (d) the total number of times accessing the media (four media-accessing means) as the dependent variables respectively for each ANOVA. Descriptively, the results showed that the advanced achievement group used more text options than the intermediate and low achievement groups: $MEAN_{low} = 87.82$, $MEAN_{inter} = 91.76$, $MEAN_{ad} = 101.36$. The mean

difference between the advanced achievement group and the low achievement group was 13.55, and the mean difference between the advanced achievement group and the intermediate achievement group was 9.61. These differences were not significantly different, yet they were different (see Table 2). This indicated that advanced achievement group looked at definitions, parts of speech, sentence examples, and relationships of words more than the intermediate and low achievement groups. The advanced achievement group also used more video options than the intermediate and low achievement groups, though the difference was not significant: $MEAN_{low}$ = 8.27, $MEAN_{inter}$ = 10.81, $MEAN_{ad}$ = 14.36 (see Table 2).

When grouped by anxiety levels. Four one-way ANOVAs were conducted with the posttest computer anxiety levels as the independent variable and four media-accessing means (see above) as the dependent variables respectively for each ANOVA. The low and intermediate anxiety groups used the text option more than the high anxiety groups: $MEAN_{low}$ = 93.46, $MEAN_{inter}$ = 94.57, $MEAN_{high}$ = 86.85; and the intermediate anxiety group used the video option more than the low and high anxiety groups: $MEAN_{low}$ = 9.46, $MEAN_{inter}$ = 12.91, $MEAN_{high}$ = 8.46 (see Table 2). However, these differences were not significant.

Insert Table 2 Here

Number of times accessing the tools. The number of times accessing different tools referred to the total number of times a participant used the different types of the tools which included the index, help, map, notetaking, and exercise tools.

The multiple regression results showed that there was not a significant relationship between achievement, anxiety, and the total number of times the participants used the tools. However, a study on the mean scores, using ANOVAs, of the different tools used for the three achievement groups (low, intermediate, advanced) and the three levels of computer anxiety (low, intermediate, high) revealed some interesting findings.

When grouped by achievement levels. Six one-way ANOVAs were conducted with the posttest achievement levels as the independent variable and (a) the number of times accessing the index tool, (b) the number of times accessing the on-line help tool, (c) the number of times accessing the map tool, (d) the total number of times accessing the notetaking tool, (e) the number of times accessing the exercise, and (f) the total number of times accessing the tools (six tool-accessing means) as the dependent variables respectively for each ANOVA. The results showed that a trend in the learning patterns among the low, intermediate, and advanced achievement groups existed in that the advanced achievement group used the notetaking tool more: $F(2,62) = 2.02$, $p = .14$, $MEAN_{low} = 4$, $MEAN_{inter} = 2.44$, $MEAN_{ad} = 13.18$. The post hoc Fisher-test showed that the difference between the intermediate achievement group and the advanced achievement group for using the notetaking tool was significant, Fisher-test = 10.72, $p < .05$ (see Table 3). The three achievement groups, however, did not differ from each other in terms of accessing the on-help tool, the map tool, and the exercise tool (see Table 3). The trend in the learning patterns also showed that the total number of tools used for the advanced achievement group was more than those used by the low and intermediate achievement groups, though the difference was not statistically significant: $F(2,62) = 2.01$, $p = .14$, $MEAN_{low} = 20.36$, $MEAN_{inter} = 21.93$, $MEAN_{ad} = 36.46$ (see Table 3). Finally, a look at the means scores descriptively showed that the advanced achievement group used the index tool more than the other groups:$MEAN_{low} = 9$, $MEAN_{inter} = 10.95$, $MEAN_{ad} = 15.64$ (see Table 3).

When grouped by achievement levels and learning styles. A descriptive look at the mean scores using six three-way ANOVAs with learning styles, the posttest achievement levels, and the posttest computer anxiety levels as the independent variables and six tool-accessing means (see above) as the dependent variables respectively for each three-way ANOVA showed that the advanced achievement FI group and the advanced achievement Mixed group tended to use the index tool more than the intermediate and low achievement FI groups and the intermediate and low Mixed achievement groups. The advanced achievement FD participants, on the other hand, used the index tool the least —fewer times than the low and intermediate achievement FD groups (see

Figure 1). The total number of tools used for the advanced FD group was the least of all the groups. No other meaningful results were found.

When grouped by anxiety levels. Six one-way ANOVAs were conducted with the posttest computer anxiety levels as the independent variable and six tool-accessing means (see above) as the dependent variables respectively for each ANOVA. One interesting finding was that the low level computer anxiety participants used the exercise tool significantly more often than the intermediate and high level computer anxiety participants: $F(2,62)= 4.2$, $p <.01$, $MEAN_{low} = 7$, $MEAN_{inter} = 4.89$, $MEAN_{high} = 4.15$, $p < .01$ (see Table 3). The high anxiety group across the three learning style groups used fewer exercise options than the low anxiety groups, and the low anxiety FI group used the exercise options the most, based on the three-way ANOVA with learning style, achievement levels, and computer anxiety as the independent variables, and the number of times using the exercise as the dependent variable (see Figure 2). Descriptively, the results also showed that the intermediate anxiety level used more notetaking tools: $MEAN_{low} = 1.92$, $MEAN_{inter} = 6.65$, $MEAN_{high} = 1.39$. The three levels of computer anxiety groups, however, were not much different in terms of how to use the on-help tool, the map tool, and the index tool (see Table 3).

Insert Table 3 Here

Insert Figure 1 Here

Insert Figure 2 Here

Research question seven was "Which type of learning aids will best meet learners' different needs?" To answer this question, ANOVAs were conducted to see if there was any

differences among the different achievement groups and different computer anxiety groups in accessing the learning aids.

Number of times accessing the learning aids. The number of times accessing different learning aids was determined by the total number of times a participant chose to use the different aids of each of the 80 words taught. Learning aids included definition, parts of speech, sentence examples, video context, and relationship of a word.

When grouped by achievement levels. Five one-way ANOVAs were conducted with the posttest achievement levels as the independent variable and (a) the number of times accessing the definition, (b) the number of times accessing the part of speech, (c) the number of times accessing the sentence examples, (d) the total number of times accessing the video context, and (e) the number of times accessing the relationship (five learning-aid-accessing means) as the dependent variables respectively for each ANOVA. A descriptive study of the results showed that the low achievement group used the definition option more often than the intermediate and advanced achievement groups: $MEAN_{low} = 40.73$, $MEAN_{inter} = 30.27$, $MEAN_{ad} = 33.09$. However, the advanced achievement group used the sentence example option more: $MEAN_{low} = 23.91$, $MEAN_{inter} = 29.66$, $MEAN_{ad} = 38.09$ (see Table 4). Relationship options, on the other hand, seemed to be a favorable choice for the intermediate achievement group: $MEAN_{low} = 20.55$, $MEAN_{inter} = 28.93$, $MEAN_{ad} = 23.27$. Although these differences were not statistically significant, they reflected some trend of the different learning patterns of the different groups.

When grouped by achievement levels and learning styles. Five three-way ANOVAs with learning styles, the posttest achievement levels, and the posttest computer anxiety levels as the independent variables and five learning-aid-accessing means (see above) as the dependent variables respectively for each three-way ANOVA. Descriptively, the results showed that the low achievement Mixed and FI groups used more of the definition option than the other groups (see Figure 3). The advanced FD and Mixed groups used more sentence examples than the advanced FI group (see Figure 4), and the advanced FI group used the relationship option more often than the

low and intermediate achievement FI groups (see Figure 5). There were no other meaningful results.

When grouped by anxiety levels. Five one-way ANOVAs were conducted with the posttest computer anxiety levels as the independent variable and five learning-aid-accessing means (see above) as the dependent variables respectively for each ANOVA. The results on computer anxiety in relation to the learning aids showed that the high anxiety group used the definition option significantly more times than the low and intermediate anxiety groups: $F(2,62)= 3.06$, $p < .05$, $MEAN_{low} = 38.08$, $MEAN_{inter} = 26.68$, $MEAN_{high} = 43.92$. The post hoc Fisher-test showed that the difference between high and intermediate anxiety groups was significant, $p < .05$ (see Table 4). A trend of the intermediate anxiety group chosing the video context option more than the other two levels of anxiety groups existed: $F(2,62) = 1.56$, $p = .22$, $MEAN_{low} = 7.77$, $MEAN_{inter} = 12.39$, $MEAN_{high} = 6.64$. The low anxiety FD group was found to use the video context option the most as a result of the three-way ANOVA with learning styles, the posttest achievement levels, and the posttest computer anxiety levels as the independent variables and the number of times using the video context as dependent variable (see Figure 6). There is also a trend for the intermediate anxiety group to use the relationship option more than the other groups: $F(2,62) = 2.09$, $p = .13$, $MEAN_{low} = 26.08$, $MEAN_{inter} = 30.89$, $MEAN_{high} = 14.31$ (see Table 4). The difference between the intermediate anxiety level and the high anxiety level in terms of using the relationship option, according to the Fisher-test, was significant: Fisher-test = 16.23, $p < .05$.

Insert Table 4 Here

Insert Figure 3 Here

Insert Figure 4 Here

Insert Figure 5 Here

Insert Figure 6 Here

DISCUSSION

Achievement

The participants' performance in achievement increased significantly from pre-treatment to post-treatment. The finding provides support to the theoretical framework of this study and indicates that semantic-network-based Hypermedia-assisted-instruction is effective in improving the language skills of the participants. This result is not surprising, because the Hypermedia-based courseware on vocabulary developed for the study (HAVLC) took advantage of multimedia capabilities, made meaningful connections among the relevant information, and presented the information in an efficient and meaningful way. It provided the learners with a rich context of the actual use of language as well as the different linguistic features of the words. Learners were given the opportunity of practicing listening, reading, and writing skills within a single environment. As indicated by the multiple choice question part of the achievement test, the participants, on the average, increased their understanding of the 80 vocabulary words from a mean of 37.71 in the pretest to a mean of 73.59 in the posttest, an average increase of almost 36 words. Moreover, the sentence making score increased from a mean of 37.67 in the pretest to a mean of 129.86 in the posttest. This finding is particularly significant, as it indicates that the courseware has provided a substantial number of opportunities for the learners to use the words in appropriate contexts. The participants not only performed better on the posttest but also retained much of what they learned.

The sentences and words used in the fill-in-the-blank part of the achievement test were taken directly from the movie *Citizen Kane*. The fact that the participants could still, averagely speaking, correctly fill in the blanks in 15 out of 20 sentences in the retention test shows that the multimedia features of the courseware and the network-format of information presentation and representation were effective means in helping learners to retain the information. All these support the notion that information needs to be processed at a deeper level in order to be better understood and retained. The findings also support other studies that found that a semantic-based and meaningful computer-assisted-language-learning (CALL) is more beneficial than directive and less communicative CALL (Robinson et al, 1985; Schaeffer, 1981).

The pre-proficiency level was found to have a significant effect on the achievement scores, thus confirming the notion that performance would be affected by different levels of proficiency. As the entry language level of the high proficiency group was better than the low and intermediate proficiency groups, it is not surprising to see the high proficiency group performing better than the low and intermediate proficiency groups. That the low proficiency group gained the most from pre-treatment to post-treatment is also understandable as they had more room to improve than the other two groups.

Computer Anxiety and Computer Attitude

For the 63 participants, computer anxiety decreased from pre-treatment to post-treatment. This finding is in line with many studies which have shown that computer anxiety can be significantly decreased after some exposure to computer instruction (Honeyman & White, 1987; Marcoulides, 1988; Reed & Palumbo, 1987/1988). The performance in achievement was found to be related to the levels of computer anxiety: the low anxiety group tended to perform better than the high anxiety group. The finding not only supports the other studies that computer anxiety is an important factor in computer instruction and can be reduced but also shows that Hypermedia-Assisted-Instruction can be an effective medium to reduce computer anxiety. This study also found that computer attitudes of the participants improved significantly from pre-treatment to post-treatment. Computer attitudes related positively to the achievement scores. That is, those with

relatively better attitudes toward computers performed better on the achievement test. This finding supports the notion that attitudes toward computers often play an important role in instruction using computers (Kulik, Bangert, & Williams, 1983; Richards, Johnson & Johnson, 1986) and students' attitudes are predictive of their achievement (Aiken, 1976; Roettger, Szymczuk, & Millard, 1980).

Learning Styles

Though the importance of cognitive learning styles and their impact on learning have been widely recognized, research findings on the Field-dependent (FD) versus Field-independent (FI) learning styles have been conflicting. Burger (1985), in his study, found no significant differences between FD and FI learning styles. Other studies showed that FI students performed better than FD students (Annis, 1979; Moorer & Dwyer, 1992). The relationship between the FD/I learning styles and Hypermedia learning environments is a new area in which little research has been done to date. The results of this study showed that there was no difference in performance among the FD, Mixed, and FI learning style groups at the post-treatment point. Since all three groups gained significantly from pre-treatment to post-treatment, it can, therefore, be said that all three learning style groups reached statistically equivalent achievement levels.

This "equality" seems to refute the common belief that, because of the lack of structure and a large amount of information available in a "typical" Hypermedia-based learning environment, FI people (who tend to approach a problem analytically and attend to details) are likely to outperform the FD people (Weller, Repman, & Rooze, 1992).

The results of this study, however, are not surprising if the courseware used in the treatment is examined. The HAVLC has a theoretical basis of the semantic-network theory and deeper level processing theory. It employed a flooding and focusing technique to inundate learners with rich information through multimedia and to provide focus on the linguistic features of words through a semantic network. The 80 words to be learned in the courseware were highlighted and embedded in the context. A click on each of these words presented five options of the word: its definition, its part of speech, the sentence examples, the video context (accompanied by the

transcript of the text and the word overlaid on the screen), and its relationship with other words. Some textual definitions of the words were also accompanied by graphics representations of the words and the learner was free to choose. The emphasis of learning was placed not only on the definitions of the words but also, more importantly, on the appropriate use of the words in the context. The relationship option of a word emphasized the semantic relationship between the target word and other words. Features included in the relationship option were synonyms and antonyms of the words and the semantic map on the usage of words. The learner could explore each or all of these five options for each of the 80 words. After looking at the linguistic features of the words, learners could go back to the video and see the words used in a larger context. The learners could choose to look at the different options of a word or view the video as many times as they desired. Learners had the ultimate control of the courseware, yet advice was given at various critical stages to provide guidance. This learner control with advisement design principle imposed some structure upon a less structured environment.

This flooding and focusing technique allowed FI participants to focus their attention to details, while it also enabled FD participants to view language-use in a realistic context provided through the multimedia aspects of the courseware. This finding that both FD/I participants performed well in the semantic-network-based Hypermedia environment supported Brown's two hypotheses (1987) on learning styles and language learning: (a) a FI person is more appropriate for a formal classroom setting involving analysis, mastering of exercises, and other focused activities; and (b) a FD person is more likely to be successful in learning the communicative aspects of a language.

This explanation is further supported by the different learning strategies employed by the FD and FI people (Liu, 1992b). The findings showed that the FD learning style group chose the video media more than the FI and the Mixed learning style groups. The FI group tended to use the index tool more often than the other groups. Interestingly, the video context option seemed to be a choice for the FD participants, while the relationship option was the choice of the FI group. The Mixed learning style group, on the other hand, used the sentence example option the most. That is,

the different learning style groups approached learning quite differently, and yet learning style did not affect achievement. This suggests that a Hypermedia environment may be so rich that learning style differences are accommodated.

Learning Patterns

By achievement. Lower achievement participants spent more time using the courseware. This can be accounted for by the fact that the lower achievement participants were slow in learning and needed more time to complete the courseware.

The video and text are the two most important media in the courseware. It is not surprising that the advanced achievement group used these two forms more than the low and intermediate achievement groups. That is, the video and text options contributed, to some extent, to the high performance of the advanced achievement participants. In studying what type of text options that the different achievement groups used, it was found, interestingly, that the low achievement group used more definitions of the words than the other two achievement groups. This can be explained by the fact that knowing definitions of the words is a familiar technique in language learning. Looking up words in the dictionary and memorizing the definitions have long been a practice in the language classrooms. When learning in a Hypermedia environment, the low achievement group resorted to this familiar method while the intermediate and advanced achievement groups were more adventurous and explored other available relevant information on the use of the words. The advanced achievement group used the sentence examples more, and the intermediate achievement group used the relationship option more. The results have shown that the sentence examples, the video context, and the relationship options are valuable resources for vocabulary learning and are important means to increase achievement levels. Although the difference in accessing the graphics media was not significant among the three achievement groups, the low achievement group used more graphics than the other two achievement groups (see Table 2). This may mean that graphics can be an important learning aid for the low achievement participants, as it is more visual and direct than the textual information.

The advanced achievement participants used more tools in total than the low and intermediate achievement groups. The advanced achievement FI participants and the advanced achievement Mixed participants used the index tool more than the intermediate achievement FI participants and the intermediate achievement Mixed participants. The intermediate achievement FI participants and the intermediate achievement Mixed participants used the index tool more often than the low achievement FI and Mixed participants. It appears that the number of times the index tool was used depended not only on learning styles but also on the participants' achievement level, indicating that, in order to move freely within the Hypermedia learning environment, a certain sense of achievement may be an important factor. It is very interesting to note, however, that the advanced achievement FD participants used the index tool the least (see Figure 1). This shows that FD and FI participants approached the same learning environment very differently. Though the FD people did not move around as freely as the FI people, they did manage to obtain the same amount of information through a more global approach, as indicated in the results on the achievement tests. The notetaking tool appears to be a valuable learning aid for the advanced achievement group as they tended to use it significantly more than the other achievement groups. In other words, the use of notetaking may have contributed, in part, to the success of the advanced achievement group.

By computer anxiety. In accessing the different learning aids, the high anxiety group was found to view more definitions than the other two anxiety groups. The interpretation for this is similar to the one given for the low achievement group: because those in the high anxiety group were very anxious in a new learning environment, they tended to use what they were familiar with. This also shows that the definition of a word is still an important component in vocabulary learning, especially for the slow and high anxiety learners. The low and intermediate anxiety participants understandably used the relationship option more than the high anxiety group. It is interesting to find that the high anxiety group also used fewer video context options than the low and intermediate anxiety groups. This indicates that listening and viewing more information than simply the definition can create more anxiety in the participants.

In terms of the different tools used, the notetaking tool was a favorite choice for the intermediate anxiety group and the exercise tool was a favorite choice for the low anxiety group. The low anxiety FI group used the exercise tool the most. Research has shown that levels of computer anxiety are often associated with the levels of performance: those with greater computer anxiety often performed more poorly (Honeyman & White, 1987; Marcoulides, 1988; Reed & Palumbo, 1987/1988). Since the notion of exercise involves right or wrong answers, it is not surprising to see that the high anxiety group tended not to choose it. This point is further supported by the fact that the choice of doing exercises is voluntary, depending on the learners themselves.

SUMMARY AND CONCLUSION

The achievement scores of the 63 participants increased significantly from pre-treatment to post-treatment. They not only increased their vocabulary but also improved their ability to use the words appropriately. This finding proves that the semantic-network-based Hypermedia vocabulary learning environment is effective.

The finding that the participants' anxiety was reduced and that their attitudes increased significantly are consistent with other research on anxiety and attitudes and indicates that anxiety and attitudes are important factors in computer-based instruction.

Learning style did not have a significant impact on achievement, yet all learning style groups increased their achievement scores significantly. This implies that the semantic-networked-based Hypermedia vocabulary learning environment accommodated learners with different needs. This implication is supported by the different learning strategies employed by the field-dependent and field-independent people. The results also showed that different achievement groups and anxiety groups used different tools and different learning aids to accomplish their learning tasks, providing evidence that different learning tools are needed for people with different learning characteristics.

In conclusion, the research findings of this study have provided some evidence that a semantic-network-based Hypermedia language learning environment can be effective. The findings support the assumptions that deep levels of information processing and multimedia aspects are

important factors for a successful learning environment. The study has confirmed other studies that indicate providing a realistic learning environment is a key factor for language learning. It is encouraging to see that the findings of this study have provided some support to the assumption that Hypermedia-assisted-instruction holds promise for accommodating learners with different characteristics, as they attempted to "discover" the most suitable ways of learning.

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Table 1

Mean Scores of Data Collection Points for Pretest, Posttest and Retention

		data collection points		
	count	pre-treatment	post-treatment	retention
Pre-proficiency				
Low	21	19.86	81.24	72.05
Intermediate	21	30.86	83.14	75.81
High	21	44.86	91.05	87.29
Learning Styles				
FD	14	35.5	85.86	77.5
Mixed	31	33.29	85.39	80.1
FI	18	26.56	84.17	76.11

Table 2
Means and Standard Deviations (in Parenthesis) of the Number of Times Accessing the Media

		different types of media			
	count	# of times use text	# of times use video	# of times use graphics	Total # use media
Post-achievement					
Low	11	87.82 (24.42)	8.27 (6.71)	3.27 (2.69)	99.36 (29.92)
Intermediate	41	91.76 (38.03)	10.81 (11.30)	2.56 (2.79)	105.12 (44.85)
Advanced	11	101.36 (49.53)	14.36 (12.36)	2 (3.07)	117.73 (58.25)
CANX					
Low	13	93.46 (37.21)	9.46 (7.56)	3.23 (2.8)	106.15 (40.8)
Intermediate	37	94.57 (44.08)	12.91 (12.91)	2.30 (2.89)	109.27 (52.87)
High	13	86.85 (13.90)	8.46 (5.91)	2.77 (2.65)	98.08 (17.2)

Table 3

Means and Standard Deviations (in Parenthesis) of the Number of Times Accessing the Tools

		different types of tools					
	count	# of times use index	# of times use help	# of times use map	# of times use note	# of times exercise	Total # use tools
Post-achievement							
Low	11	9 (9.07)	.91 (1.3)	1.46 (1.21)	4 (9.07)	5 (2.65)	20.36 (11.16)
Intermediate	41	10.95 (14.01)	1.44 (2.04)	1.56 (3.12)	2.44 (4.39)	5.53 (2.74)	21.93 (18.39)
Advanced	11	15.64 (20.53)	1 (1.18)	2.64 (3.11)	13.18* (36.54)	4 (3.1)	36.46 (39.3)
CANX							
Low	13	7.46 (6.06)	1.77 (2.59)	1.92 (2.1)	1.92 (3.28)	7** (2.24)	20.08 (8.95)
Intermediate	37	12.97 (16.23)	.95 (1.35)	1.57 (1.95)	6.65 (20.69)	4.90 (2.86)	27.03 (25.89)
High	13	11 (15.62)	1.69 (1.93)	2 (5.16)	1.39 (1.66)	4.15 (2.48)	20.23 (23.12)

* = significantly different from the intermediate achievement group, $p < .05$
** = significantly different from the intermediate and high anxiety groups, $p < .05$

Table 4

Means and Standard Deviations (in parenthesis) of the Number of Times Accessing the Learning Aids

		different types of learning aids				
	count	# of times use definition	# of times use parts of speech	# of times use sentence examples	# of times use video context	# of times relationship
Post-achievement						
Low	11	40.73 (21.56)	2.64 (2.16)	23.91 (27.9)	6 (5.78)	20.55 (14.02)
Intermediate	41	30.27 (24.8)	4.78 (8.12)	29.66 (24.45)	10.29 (12.6)	28.93 (29.04)
Advanced	11	33.09 (24.49)	6.91 (11.06)	38.09 (20.69)	14.18 (12.48)	23.27 (20.52)
CANX						
Low	13	38.08 (20.8)	4.69 (8.97)	24.62 (23.6)	7.77 (7.35)	26.08 (27.75)
Intermediate	37	26.68 (23.76)	5.7 (8.93)	33.38 (24.3)	12.38 (14.12)	30.89** (26.41)
High	13	43.92* (24.72)	2.23 (2.2)	26.39 (26.14)	6.54 (5.44)	14.31 (17.47)

* = significantly different from the intermediate anxiety group, $p < .05$
** = significantly different from the high anxiety group, $p < .05$

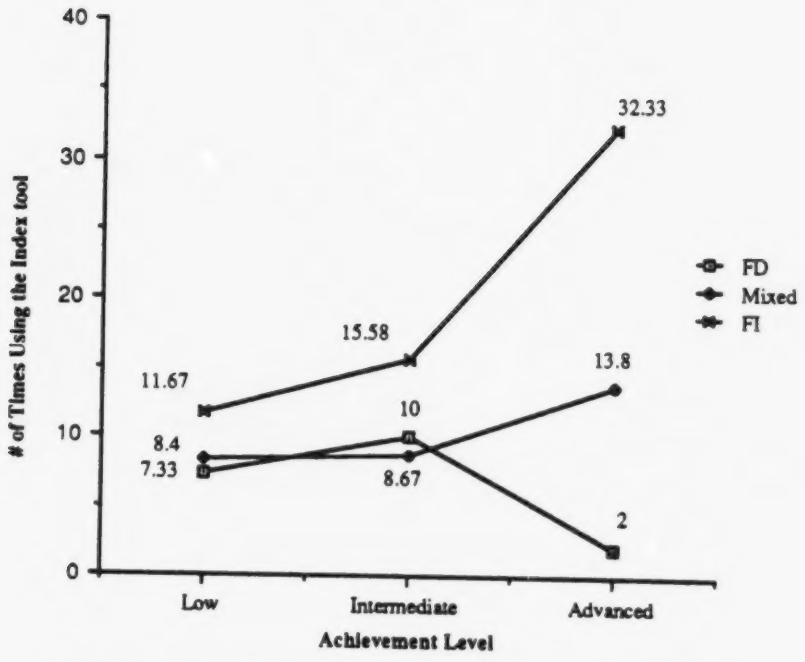

Figure 1. Learning Style By Achievement Level on the Use of Index

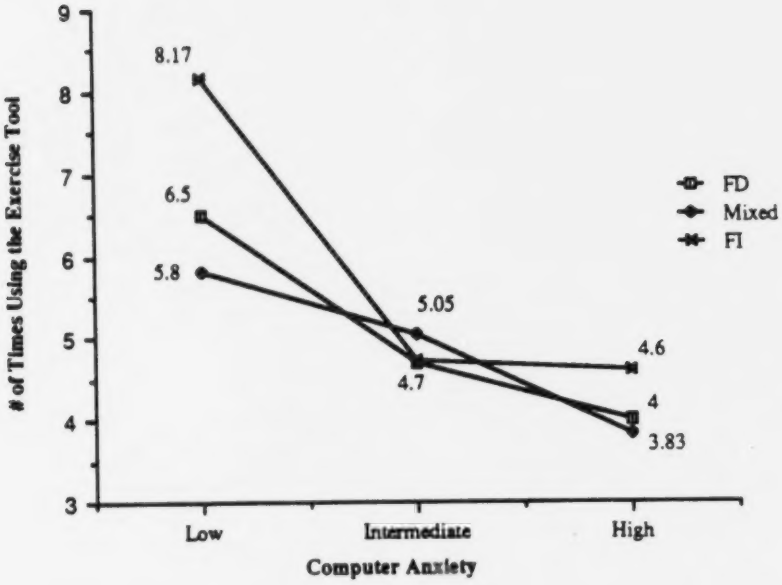

Figure 2. Computer Anxiety By Learning Style on the Use of Exercise

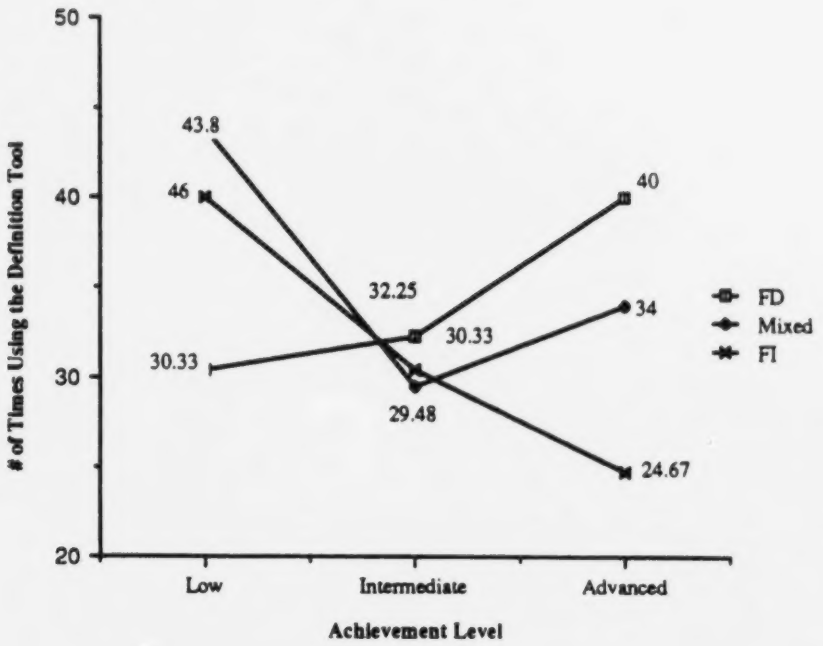

Figure 3. Learning Style By Achievement Level on the Use of Definition

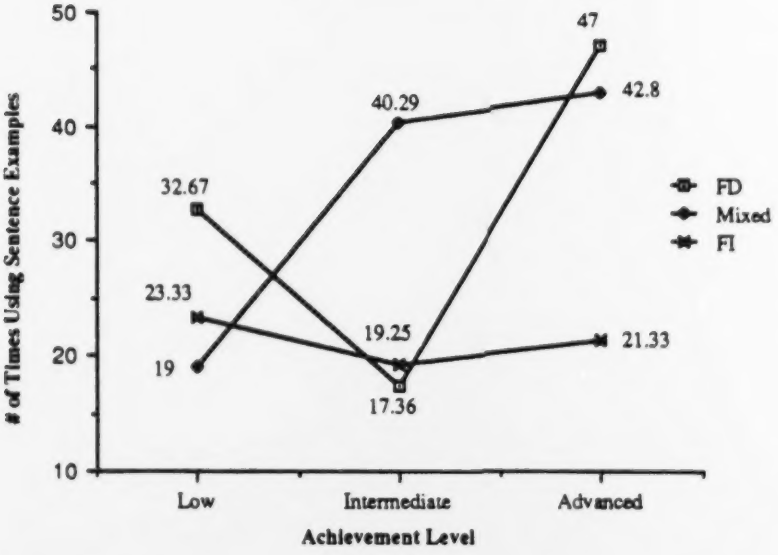

Figure 4. Learning Style By Achievement Level on the Use of Sentence Examples

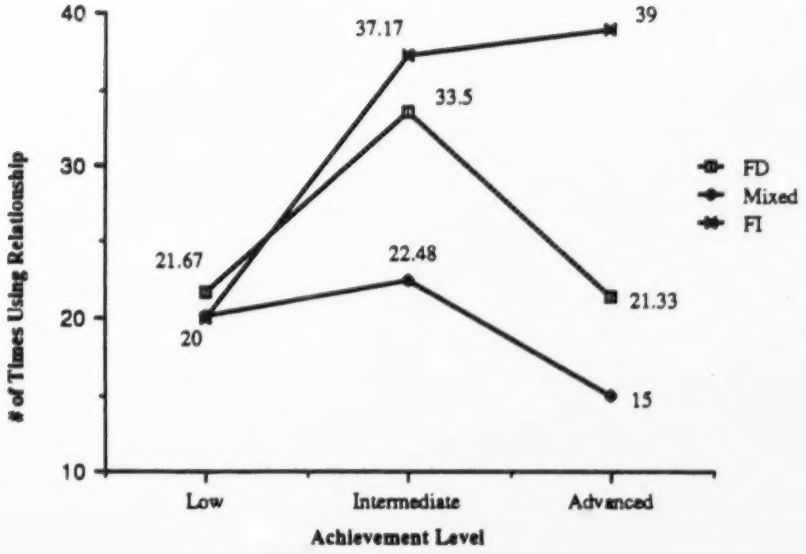

Figure 5. Learning Style By Achievement Level on the Use of Relationship

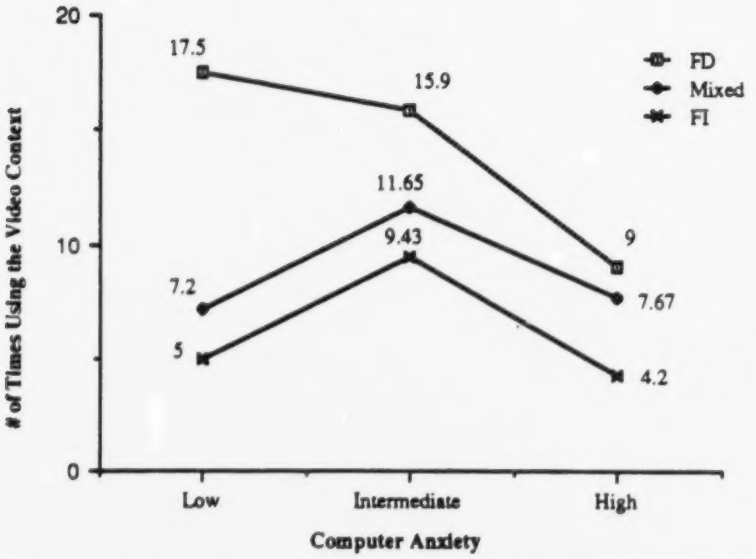

Figure 6. Computer Anxiety By Learning Style on the Use of Video Context